PACIFIC SOUTHWEST
Forest and Range
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FOREST SERVICE
U.S.DEPARTMENT OF AGRICULTURE
P.O. BOX 245, BERKELEY, CALIFORNIA 94701

FIRES CAUSED BY EQUIPMENT used during critical fire weather in California, 1962-1971

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USDA Forest Service
Research Note PSW-289
1974

Abstract: Use of certain types of equipment during fire season is a major cause of forest fires in California. To determine what these types are and the characteristics of people using them, the Fire Investigation Reports for one unit of the California Division of Forestry were analyzed for critical fire weather periods over a 10-year span. Roadway vehicles—automobiles and trucks—were responsible for most of the equipment-use fires. But few such fires when starting in critical fire weather reached major proportion. Most of the major roadway vehicle fires started during non-critical periods. Recommendations for improving the Fire Investigation Reports and for new regulatory measures are offered.

Oxford: 431.3(794).
Retrieval Terms: man-caused forest fires; automobiles; trucks; farm equipment; critical fire weather; California Division of Forestry; fire investigation reports.

Equipment use and incendiarism cause more than half of the major forest fires on land protected by the State of California. From 1962 to 1971, equipment-use accounted for 28 percent of such fires, and incendiarism, for 26 percent. The term *equipment use* includes transport vehicles (e.g., automobiles, trucks, motorcycles), farm or construction equipment (e.g., tractors, harvestors), power tools, and stationary engines.

To plan an effective fire prevention program, one of the first steps necessary is to identify the characteristics of persons using wildlands who are considered high fire risks. I decided to give priority to equipment-use fires because persons potentially responsible for such fires are easier to identify and reach than are incendiarists. If they operate equipment, these persons can be observed doing so. If they are vehicle operators, they are presumably registered as such. Incendiarists do not have such obvious characteristics that make it possible to distinguish them from other persons.

To gather data on equipment-use fires, I analyzed the Fire Investigation Reports of District V of the California Division of Forestry from 1962 to 1971. The District has the greatest incidence of equipment-use fires in the State. It consists of four Ranger Units: Santa Clara, San Mateo-Santa Cruz, San Benito-Monterey, and San Luis Obispo. Only the equipment-use fires that started during "critical fire weather periods" (CFWP) were studied because it was assumed that such fires had a greater potential to become major fires than did those that started at other times. While the assumption was not born out, the results suggest that the Reports provided valuable information in identifying the types of equipment that were responsible for forest fires during periods of critical fire weather.

METHODS

The Division of Forestry defined a "Critical Fire Weather Period" as the date or inclusive dates of days on which the fire load index was 40 or above, plus

the day before and after these days. The index includes the ignition index and those factors making up the burning index: wind speed and intensity factor (days since new growth of vegetation or buildup). Owing to a change in Division procedures, the fire load index could not be used as a criterion of critical fire weather periods for 1970 and 1971. For these two years, critical fire weather dates were defined as those on which the ignition index was 80 or more.

Only 38 equipment-use fires occurring in all types of weather from 1962 to 1971 in District V were considered major, that is, covering 300 acres or more. This number of major fires is small for drawing generalizations. Therefore, all equipment-use fires, regardless of size, that started during critical fire weather periods were studied.

The following information from individual Fire Investigation Reports was tabulated: (a) type of equipment, (b) specific fire cause, (c) responsible party–absentee owner or owner-present; local resident or worker, or traveler, (d) location, (e) date and time of fire, (f) whether fire fighting supplies provided, (g) laws violated, and (h) whether or not a complaint was filed.

Equipment was classified by ownership to determine the relationship of the responsible party (owner) to the equipment. It was classified *absentee-owned* if it was being operated by an employee of a contracting company, or of an absentee landowner who owned the equipment too. It was classified *owner present* (owner-"operated") if it was operated by the owner or by an employee of a resident owner.

As to location of fire starts, *wildlands* were loosely defined for the purpose of this study to include any uncleared area with such vegetation as brush, grass, woodlands, grain or other inflammable cultivated vegetation.

California Division of Forestry Reporting Officers are required to indicate whether a fire cause is undetermined, known, or logical.[1] They are to indicate it is "Known" if there is supporting evidence to prove the cause. When the cause is not known but can reasonably be deduced or inferred they are to indicate the cause as being "Logical." When they are unable to arrive at a known or logical cause they are to mark the cause as "Undetermined."

RESULTS

General Causes

About 70 percent of the equipment-use fires were caused by road transport vehicles rather than farm or construction equipment, power tools, or stationary engines. Of the transport vehicle fires, automobiles and trucks were the major causes:

	Fires (N=352) (percent)
Equipment:	
Vehicle (transport):	
Auto	30.4
Truck	23.8
Motorcycle	4.8
Other	1.7
Unspecified	7.4
Total	68.1
Harvestor	6.3
Tractor	7.1
Other farm equipment	3.4
Highway maintenance or construction	2.3
Power tools:	
Welding torch	4.3
Saw	1.1
Other	2.0
Total	7.4
Stationary engine	3.1
Other	2.3

Malfunctioning automobiles caused 45 percent of transport vehicle fires; trucks, 35 percent; and motorcycles, 7 percent. Fully 10 percent were recorded as "vehicle" fires without the type of vehicle being specified. Fires in more than 80 percent of these unspecified vehicle cases were logically determined (not known but deduced or inferred) to have been caused by exhaust from a passing automobile or truck. Together automobiles, trucks, and unspecified vehicles were responsible for 62 percent of all equipment-use fires during the critical fire weather periods studied. The next most frequent causes of equipment-use fires were power tools (7 percent), tractors (7 percent), and harvestors (6 percent).

Specific Causes

The pattern of specific causes of fires involving automobiles and trucks differed considerably. Automobile fires start for a variety of reasons. The most frequent causes are, in descending order, gas leaks, exhaust, faulty wiring, and friction. Most truck fires are attributed to exhaust, and 26 percent to friction.

Equal proportions–about one-third–of the harvestor fires of all sizes were attributed to exhaust and to friction *(table 1)*. But for the *major* harvestor fires, exhaust was the cause in 8 out of 11 cases.

Although more than 50 percent of truck fires were categorized as exhaust fires, 84 percent of the Fire

Table 1–*Equipment-use fires during critical fire weather periods in District V, California Division of Forestry 1962-1971, by specific fire cause and type of equipment*

Specific fire cause	Auto (N=107)	Truck (N=84)	Harvestor (N=22)	Tractor (N=25)	Other vehicle or constr. equip. (N=43)	Unspecified vehicle (N=26)	Power tools (N=26)	Others (N=19)	Total (N=352)
	Percent								
Exhaust:									
Spark arrestor									
None	–	1.2	4.5	28.0	4.6	3.9	–	15.8	5.4
Faulty	–	5.9	4.5	8.0	2.3	–	–	10.5	3.4
Ok	–	1.2	–	8.0	13.9	–	–	–	1.4
Unknown	6.5	15.5	–	4.0	9.3	73.1	–	–	13.1
Not stated	13.1	27.4	22.8	20.0	16.3	7.7	11.5	5.3	16.2
Total	19.6	51.2	31.8	68.0	44.1	84.7	11.5	31.6	39.5
Wiring	16.8	5.9	–	4.0	16.3	–	–	21.1	9.9
Friction	12.2	26.2	31.8	12.0	16.3	11.5	3.9	5.3	16.2
Gas leak	21.6	4.8	4.5	4.0	9.3	–	–	5.3	9.7
Other	28.0	10.7	31.8	12.0	11.7	–	73.1	36.8	22.4
Not stated	1.8	1.2	–	–	2.3	3.9	11.5	–	2.3

Investigation Reports of these fires had no information as to the existence, let alone condition, of a spark arrestor. The greatest proportion–40 percent–of all types of equipment-use fires was attributed to exhaust. But, as with truck fires, little information was contained in Fire Investigation Reports of other equipment-use fires concerning the existence or condition of spark arrestors. In 75 percent of all exhaust fires, the reports either had a statement to the effect that it was unknown whether there was a spark arrestor or no statement at all. The lack of this recorded information for certain types of vehicles is understandable. The State of California does not require spark arrestors on motor trucks, truck tractors, buses, and passenger vehicles, except motorcycles, unless they are operated on forest-, brush-, or grass-covered lands and do not have an exhaust system equipped with a muffler. Tractors are, however, required by law to have spark arrestors. Of the 17 tractor-exhaust fires, seven of the tractors had no spark arrestor, two had faulty spark arrestors, two had spark arrestors reported in good condition, and in the balance of cases it was unknown or not stated.

Status of Fire Cause

The causes of 66 percent of all equipment-use fires were categorized as "logical" while less than 33 percent were reported as definitely known. The specific cause of less than 3 percent was reported as undetermined. This pattern reverses itself only with power tool fires–85 percent of the specific causes were reported known.

Except for San Luis Obispo Ranger Unit, which had the greatest number of equipment-use fires in District V, the proportion of causes which were logical (as opposed to known) ranged from 53 to 60 percent. In the San Luis Obispo Unit, 75 percent of fire causes were reported as logical; 4 percent as undetermined; and 21 percent, as definitely known. This is about half the proportion of causes reported as known in the three other Ranger Units.

The proportion of fire causes reported as known doubled from 19 percent in 1962-1963 to 38 percent in 1970-1971. This increase could be attributed to steadily improving detection methods, but may have resulted from the use of temporary personnel not properly trained in reporting procedures *(table 2)*.

Responsible Party

About 50 percent of all equipment which caused fires on CFWP was owner-"operated" (owner present) and 30 percent absentee-owned. Ownership status of the balance was not reported or was reported as unknown.

Type of ownership varied considerably, depending upon the type of equipment. Responsible parties in the case of auto CFWP fire starts (of all sizes) were almost all (at least 83 percent) individual owner-operators. But in the case of truck fire starts, at least 45 percent of the trucks had absentee owners. In the harvestor fires, at least one-half of the harvestors were absentee-owned.

Owner-"operated" (owner present) equipment was further classified to determine whether the respon-

Table 2–*Equipment-use fires during critical fire weather periods in District V, California Division of Forestry, 1962-1971, by status of cause and year*

Status of cause	1962-1963 (N=42)	1964-1965 (N=40)	1966-1967 (N=85)	1968-1969 (N=111)	1970-1971 (N=74)	Total (N=352)
	Percent					
Known	19.0	15.0	33.0	34.2	37.8	30.7
Logical	81.0	80.0	63.5	63.0	60.8	66.6
Undetermined	–	5.0	3.5	2.7	1.4	2.7

sible party was a local resident, local worker, or a traveler merely passing through the vicinity. I found that in 73 percent of these fires, the owner was a local resident or worker; in 23 percent, he was a traveler; and in the remainder, the information was unknown. Chandler's[2] study of data on fire causes in the California Region, showed that 80 percent of fires *whose cause is known* were started by local residents. Christiansen and Folkman[3] also found in an analysis of Fire Trespass Reports that fire starters were more apt to be people who lived near and worked on National Forests than to be recreationists or city dwellers who had traveled there.

Location of Fire Starts

CFWP equipment-use fires started 60 percent of the time on roadways or shoulders. In the San Luis Obispo and Santa Clara Ranger Units, they are most frequent on State highways. In the San Benito-Monterey Ranger Unit, off-road fire starts in "wildlands" (uncleared areas) were slightly more frequent (45 percent) than fire starts on roads or shoulders (42 percent). Over-all, off-road fire starts on "uncleared" private lands made up 32 percent of equipment-use fire starts, and those in cleared areas 9 percent.

The incidence of equipment-use fires was greatest in the San Luis Obispo Ranger Unit. Nearly 60 percent of the fires started by vehicles there escaped and burned vegetation. For example, of the 100 automobile, truck, and "unspecified vehicle" fire starts on roadways or shoulders, 56 escaped the vehicle and burned vegetation. Most burned 50 acres or less. However, one reached 300 acres or more.

In the 10-year study period, 57 percent of the CFWP equipment-use fires in District V were concentrated in the San Luis Obispo Ranger Unit. About 22 percent occurred in Santa Clara, 18 percent in San Benito-Monterey, and the rest in the San Mateo-Santa Cruz Ranger Units.

Within the San Luis Obispo Ranger Unit, 33 percent of all the equipment-use fires occurred on or within 1 mile of U.S. Highway 101. Forty percent of these highway fires occurred on Highway 101 within 5 miles of the two Forest Fire Stations on that highway, the Nipomo and Paso Robles Forest Fire Stations. The relatively high concentration of fires within a 5-mile radius of each of these Stations is apparent.

The pattern is even more striking in the Santa Clara Ranger Unit, where the two largest clusters of equipment-use fires occurred within 5-mile radii of the Division of Forestry's Santa Clara County Headquarters on Highway 101 (13 fires) and the Alma Forest Fire Station (12 fires). Most of the latter occurred on Highway 17 between the Station and the County line to the south. Fully 69 percent of the Santa Clara Ranger Unit fires occurred within 5 miles of the Division's County Headquarters or a Forest Fire Station.

Equipment-use fires which occurred in the San Benito–Monterey and San Mateo-Santa Cruz Ranger Units were scattered and presented no general pattern.

Most likely, the clustering of equipment-use fires near the Division's Forest Fire Stations in Santa Clara and San Luis Obispo counties is due to the referral pattern for assistance requested. Within a particular area there are numerous fire jurisdictions, municipal, rural, etc., that may be called upon for aid and their fire reports are not included in the Division's statistics.

Firefighting Supplies

About 40 percent of the equipment which caused fires (of all sizes) was provided with some firefighting supplies or tools. This differed, however, depending upon the type of equipment. Almost 75 percent of power tools and other equipment, such as stationary engines, had firefighting supplies provided. Eighty percent of the tractors and 86 percent of the harvestors were equipped with firefighting apparatus. Half of the trucks were so equipped, but only 13 percent

of automobiles, were reported to be carrying any fire-fighting supplies.

Law Enforcement

Although fire investigation reports showed that in at least 20 percent of equipment fire starts fire laws had been violated, there was little indication that enforcement action would be taken in more than a handful of cases. In only three cases had complaints been filed with the courts and in only two other cases was it indicated a complaint would be filed. In another 38 cases, consideration was still being given to whether a complaint would be filed. In 21 cases, there was no statement at all in the report concerning the filing of a complaint.

Time of Fire Start

Seventy-five percent of CFWP equipment-use fires occurred from July through September, and, as might be expected, 97 percent occurred sometime between June 1 and October 31. The equipment-use fires studied were fairly evenly distributed over the week except for automobile fires. Most automobile fires occurred from Thursdays through Sundays. Truck fires were frequent from Thursdays through Saturdays, but dropped off considerably on Sundays.

Seventy percent of CFWP equipment-use fires occurred between 10:01 a.m. and 6 p.m., with the bulk or more than 40 percent occurring between noon and 4 p.m.

DISCUSSION AND CONCLUSION

The pattern that emerged from this study was: Equipment-use fires are mainly caused by automobiles and trucks on roadways. To test the implicit assumption that the pattern for *major* CFWP equipment-use fires would be the same as that for all CFWP equipment fires, I also looked at just the major fires. The causation and location pattern for the 11 major CFWP fires for the entire District over the 10 years differed from that of equipment fires of all sizes. The largest proportion of CFWP major equipment-use fires was started by harvestors and most CFWP major equipment fires started off roads in vegetation.

The discovery that what was true of CFWP equipment-use fires of all sizes was not true of the 11 major fires which started in CFWP led to an analysis of the total group of 38 major fires which occurred from 1962-71 in District V regardless of type of weather. On the basis of the limited information given in California Division of Forestry's Major Forest Fire Summaries, I determined that 40 to 50 percent of all major equipment-use fires were caused by roadway type vehicles, mainly automobiles and trucks and therefore could have started from roadways, rather than in "wildlands." The other fires were caused by equipment most likely to be used off roads in vegetation. Just under one-third were caused by harvestors.

This study of CFWP equipment-use fires showed that only one roadway vehicle fire became major, but the cause pattern of all major equipment-use fires, during all types of weather, suggests that the condition of roadway vehicles as a vital potential source of major fires should not be ignored.

RECOMMENDATIONS

Fire Investigation and related reports for identifying high fire-risk wildland using publics should continue to be used. The usefulness of these reports could be much improved, however, by the addition of several sets of questions, each set pertinent to the prevention of fires of a particular causal origin.

The following additional recommendations are offered:

1. Require by law that (a) all automobiles and trucks registered to persons residing or working in counties with a high incidence of vehicle-use fires shall be equipped with fire extinguishers, (b) all trucks registered to persons residing or working in such counties shall have spark arrestors, and (c) all transport trucks operating in California shall be equipped with both spark arrestors and fire extinguishers.

2. Replace highly flammable vegetation along highways that have a high incidence of fire starts with vegetation of lower flammability, or treat vegetation with a nontoxic fire retardant, paying the most attention to highways where the incidence of fire starts has been the greatest.

3. Conduct road checks at times and in areas where equipment-use fires are known to be relatively frequent to (a) determine the prevalence of hazardous defects, such as gas leaks, exhaust sparks, faulty wiring, mechanical friction; (b) to take corrective action, or provide warning where a defect need not be immediately corrected; and (c) collect information on vehicles and on drivers of defective and non-defective equipment, for use in fire prevention programs.

4. Enforce strictly State codes that require spark arrestors or firefighting provisions or both.

5. Revise the Fire Investigation Report, or add more questions (precoded for automatic data processing)

on equipment-use to include data on make, model, and year of vehicle; show where equipment was being operated—on roads or in wildlands; indicate evidence of roadside "fireproofing" and whether there was proper clearance in wildland areas; show if the equipment had a spark arrestor and its condition; show if required firefighting provisions were available; indicate nature of ownership—whether absentee or not; and show demographic and other characteristics of owners for owner-operated equipment.

6. Use characteristics and demographic data on equipment owners-users to design an information-education program tailored to arouse the interest of these groups in current or new legislative requirements (see first recommendation).

7. Coordinate with the U.S. Forest Service and other fire protection agencies to achieve standardized reporting procedures, so as to provide a more accurate picture of over-all fire causes and locations.

8. Maintain strict enforcement of the California Public Resources and Health and Safety Codes requiring spark arrestors and firefighting provisions on harvestors, including checking adequacy of inspection, enforcement, and followup procedures.

Acknowledgments: I thank Howard E. Moore, deputy State forester formerly in charge of fire prevention, California Division of Forestry, Sacramento, for his help in this study; and the Division for use of its Fire Investigation Reports.

NOTES

[1]California Division of Forestry. *Fire prevention handbook 6000, Fire law administration.* 74 p. 1971.

[2]Chandler, Craig C. *How good are statistics on fire causes?* J. For. 58(7): 515-517. 1960.

[3]Christiansen, John R., and William S. Folkman. *Characteristics of people who start fires. . .some preliminary findings.* USDA Forest Serv. Res. Note PSW-251. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif. 6 p. 1971.

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G. P. O. 794—473/4619